

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE (DD-MM-YYYY) 2. REPORT TYPE Technical Papers 3. DATES COVERED (From - To)

4. TITLE AND SUBTITLE 5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S) 5d. PROJECT NUMBER

2302

5e. TASK NUMBER

MIG2

5f. WORK UNIT NUMBER

346120

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) 8. PERFORMING ORGANIZATION REPORT

Air Force Research Laboratory (AFMC)
AFRL/PRS
5 Pollux Drive
Edwards AFB CA 93524-7048

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) 10. SPONSOR/MONITOR'S ACRONYM(S)

Air Force Research Laboratory (AFMC)
AFRL/PRS
5 Pollux Drive
Edwards AFB CA 93524-7048

11. SPONSOR/MONITOR'S NUMBER(S)

Please see attached

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

20030129 195

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:

a. REPORT

Unclassified

b. ABSTRACT

Unclassified

c. THIS PAGE

Unclassified

17. LIMITATION OF ABSTRACT

A

18. NUMBER OF PAGES

19a. NAME OF RESPONSIBLE PERSON

Leilani Richardson

19b. TELEPHONE NUMBER

(include area code)

(661) 275-5015

MEMORANDUM FOR PRS (In-House Publication)

GJ

FROM: PROI (STINFO)

22 May 2002

SUBJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-VG-2002-130**
C.T. Liu (PRSM); F.P. Chiang (NYSU), "Investigating the Deformation and Failure Mechanisms in Bi-Material Systems Under Tension"

ASME Winter Meeting
(Blacksburg, VA, 24-28 June 2002) (Deadline = 23 June 2002)

(Statement A)

1. This request has been reviewed by the Foreign Disclosure Office for: a.) appropriateness of distribution statement, b.) military/national critical technology, c.) export controls or distribution restrictions, d.) appropriateness for release to a foreign nation, and e.) technical sensitivity and/or economic sensitivity.

Comments: _____

Signature _____ Date _____

2. This request has been reviewed by the Public Affairs Office for: a.) appropriateness for public release and/or b.) possible higher headquarters review.

Comments: _____

Signature _____ Date _____

3. This request has been reviewed by the STINFO for: a.) changes if approved as amended, b.) appropriateness of references, if applicable; and c.) format and completion of meeting clearance form if required

Comments: _____

Signature _____ Date _____

4. This request has been reviewed by PR for: a.) technical accuracy, b.) appropriateness for audience, c.) appropriateness of distribution statement, d.) technical sensitivity and economic sensitivity, e.) military/national critical technology, and f.) data rights and patentability

Comments: _____

APPROVED/APPROVED AS AMENDED/DISAPPROVED

PHILIP A. KESSEL Date
Technical Advisor
Space and Missile Propulsion Division

Investigating the Deformation and Failure Mechanisms in Bi- Material Systems under Tension



C.T. Liu
AFRL/PRSM 10 E. Saturn Blvd.
Edwards AFB CA 93524-7680

Fu-Pen Chiang
Department of Mechanical Engineering
State University of New York
Stony Brook, N. Y. 11790



Objectives



≠ Investigate the Local Strain Distribution and Failure Mode in a Bi-Material Bonded

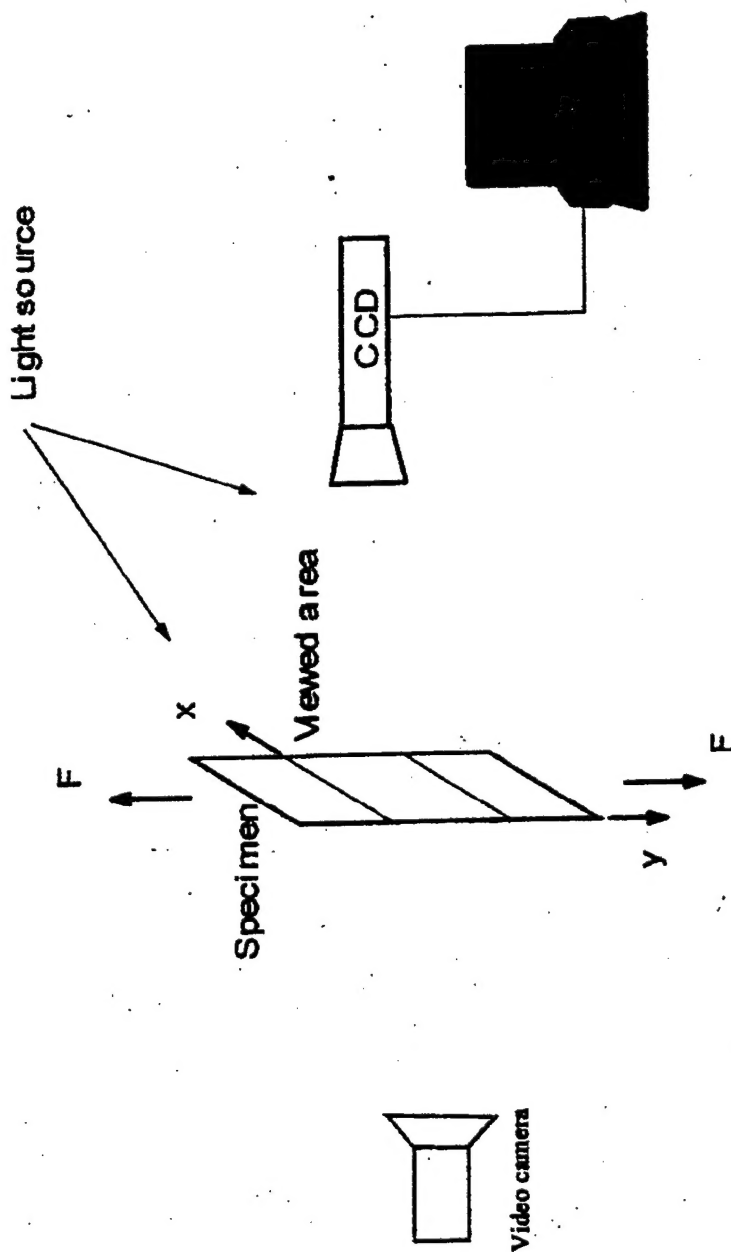
—Specimens under a Constant Displacement Rate Condition.

* Displacement Rate = 0.02 in/min

≠ Determine the Critical Strain for Debond at the Interface between the Two Materials.



Experimental Set-Up



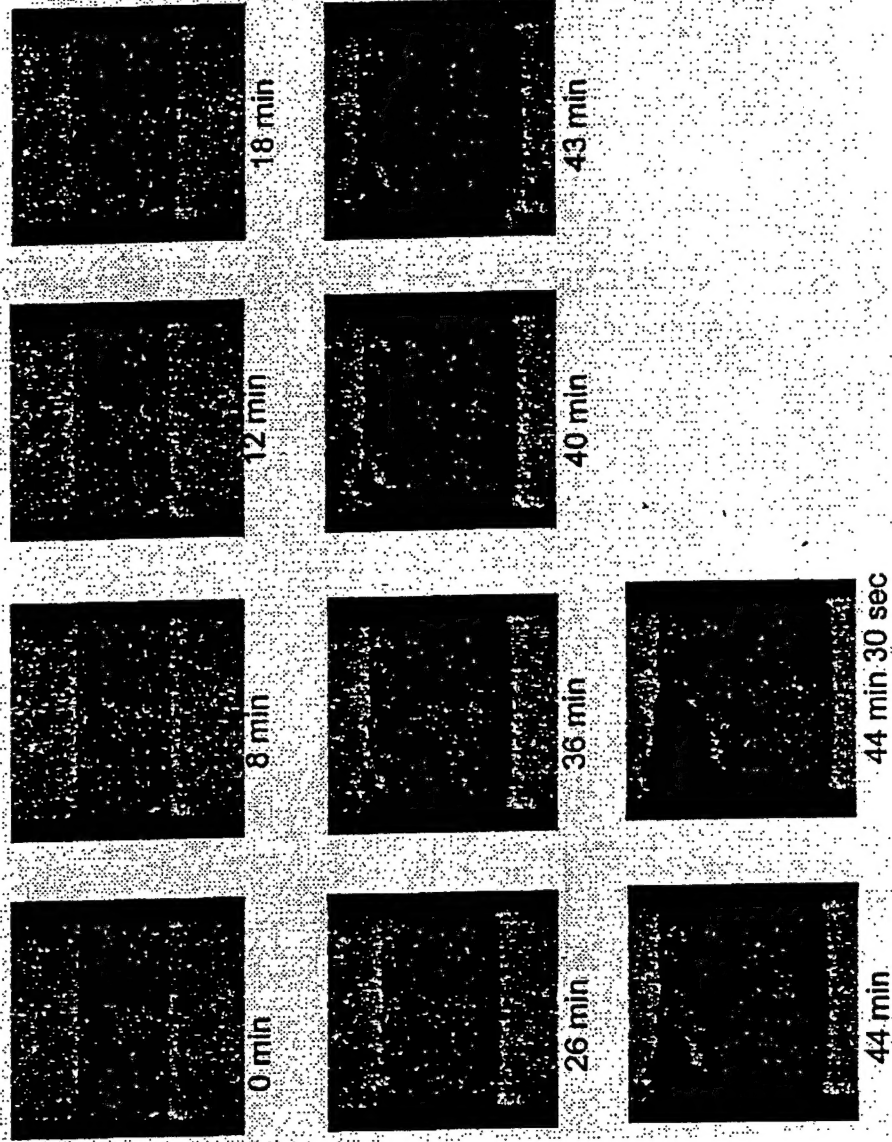


A10/1 pp4

The Mechanism of Debonding



Thickness to Width Ratio: 1:1:00

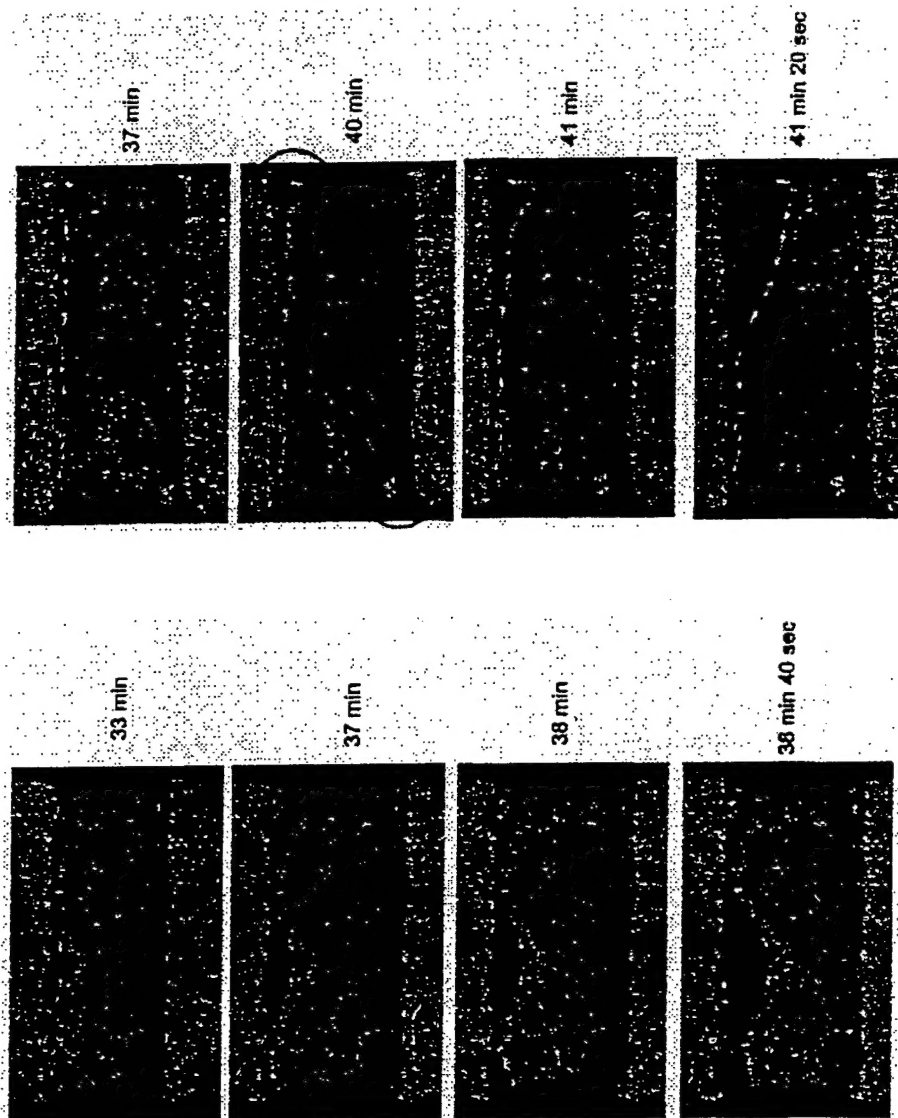




The Mechanism of Debonding



Thickness to Width Ratio: 1:2.25

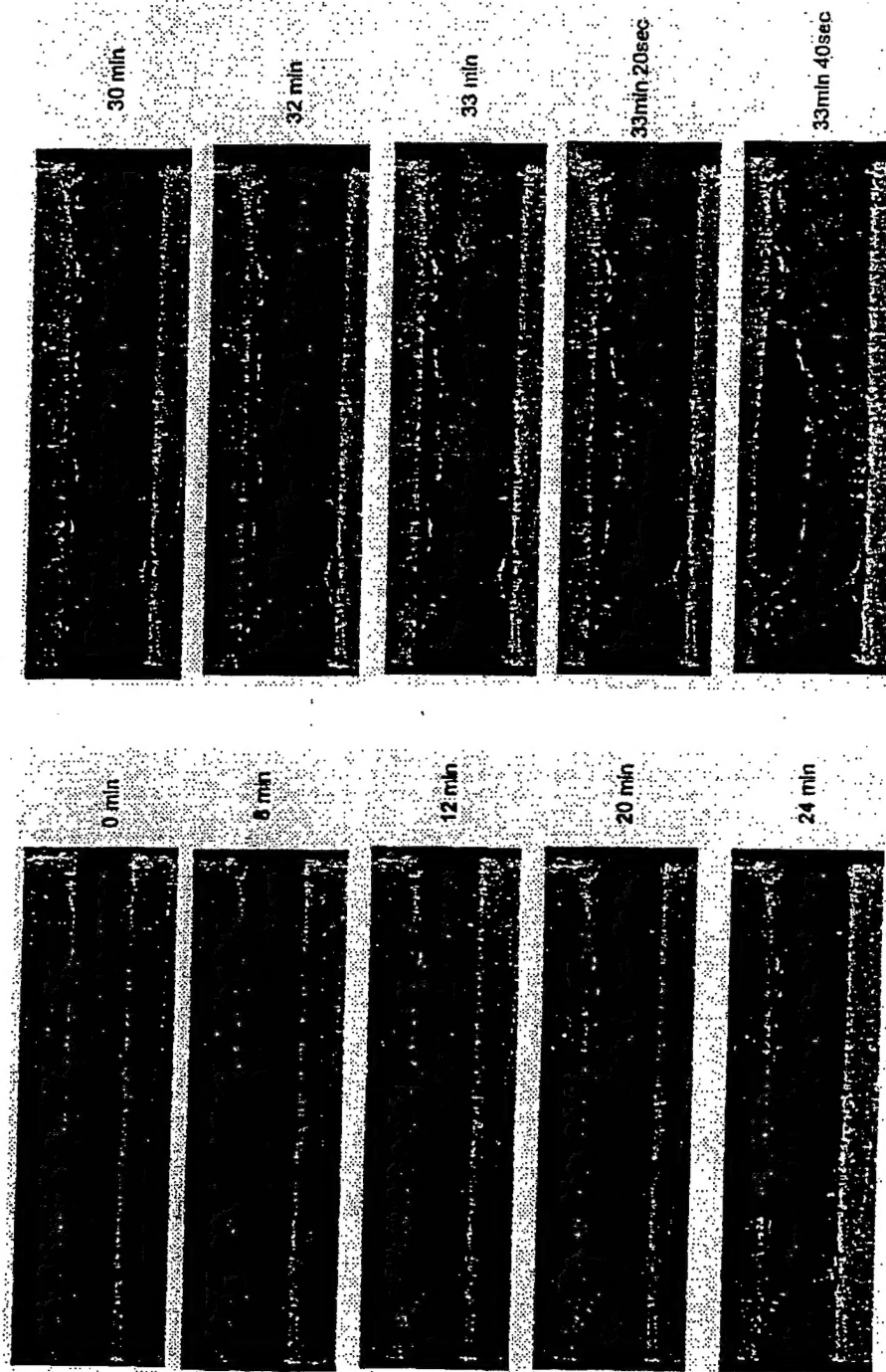




The Mechanism of Debonding



Thickness to Width Ratio: 1:5.00





The Debonding Modes



Size: t x w (in)	Ratio: t:w	Number of Specimens	Debond at center	Debond at corner
0.2 x 1	1:5	2	2	0
0.2 x 0.5	1:2.5	3	3	0
0.2 x 0.4	1:2	4	1	3
0.2 x 0.2	1:1	2	0	2

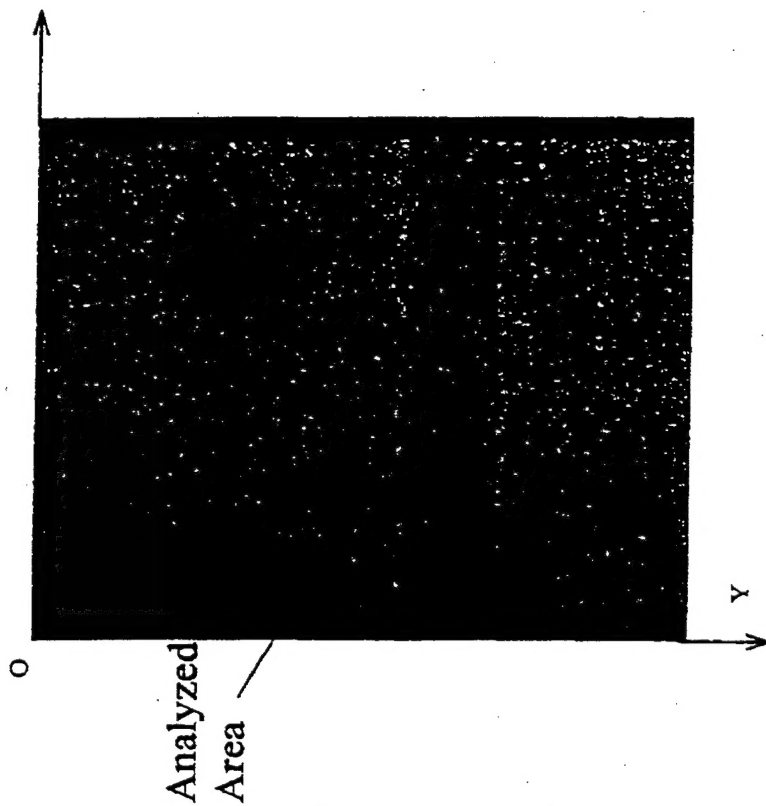
H ~ 4 in
h ~ 0.1 in

Critical ratio: ~ 1:2.25; either mode may prevail



A1971.ppt

Analysis of Deformation

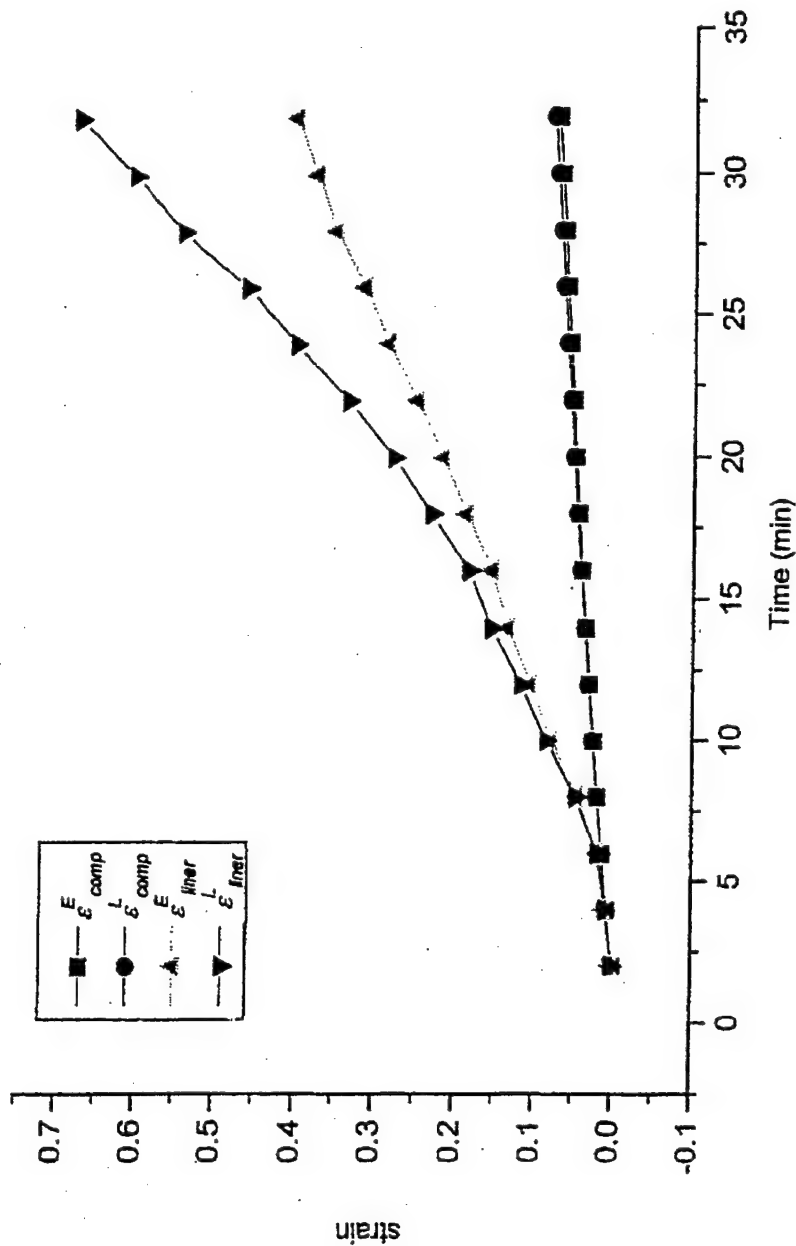




Average Strain Versus Force Curves



Thickness to Width Ratio: 1:5.00





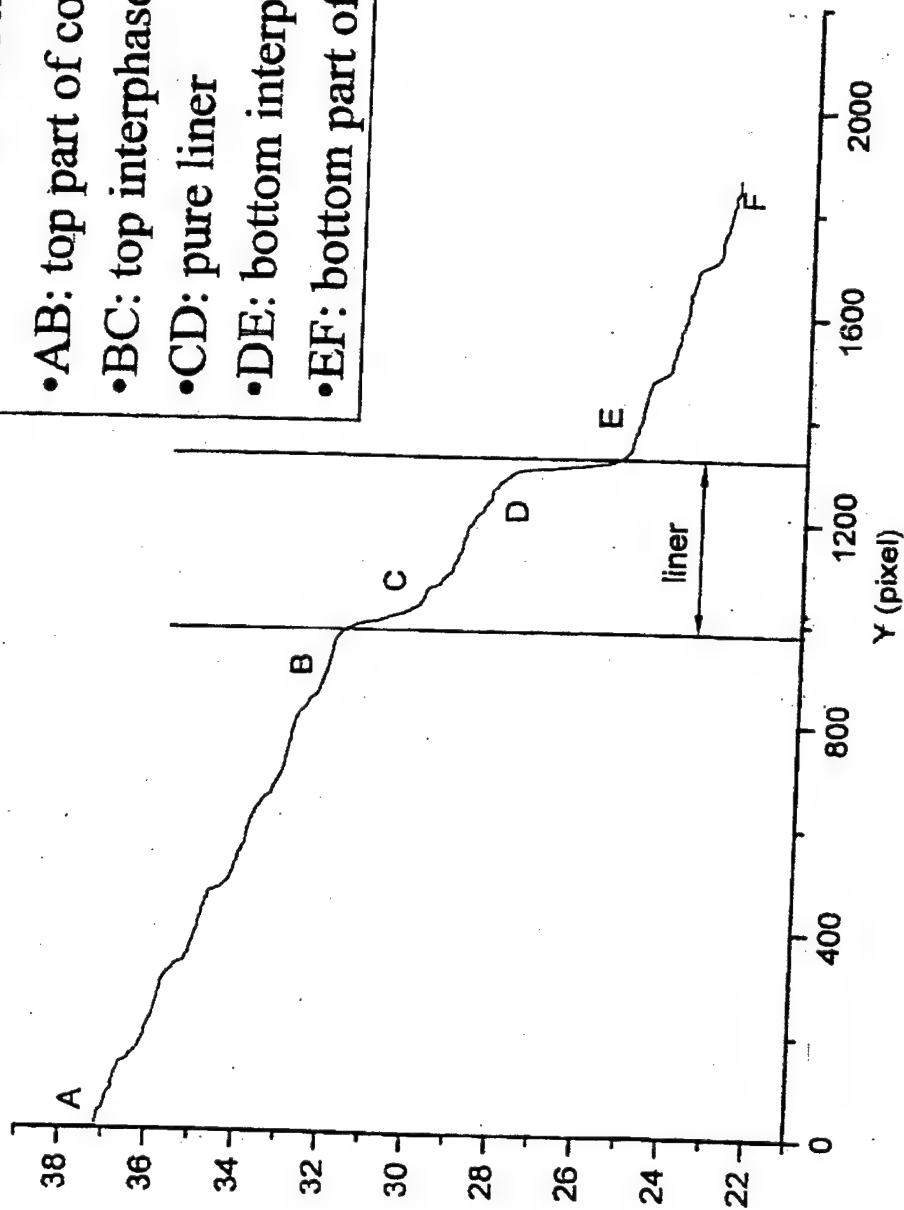
A1071 pp8

Displacement Increment Distribution along y

Direction



displacement increment between 8 and 10 min
 Δv (pixel)



Five linear sections:

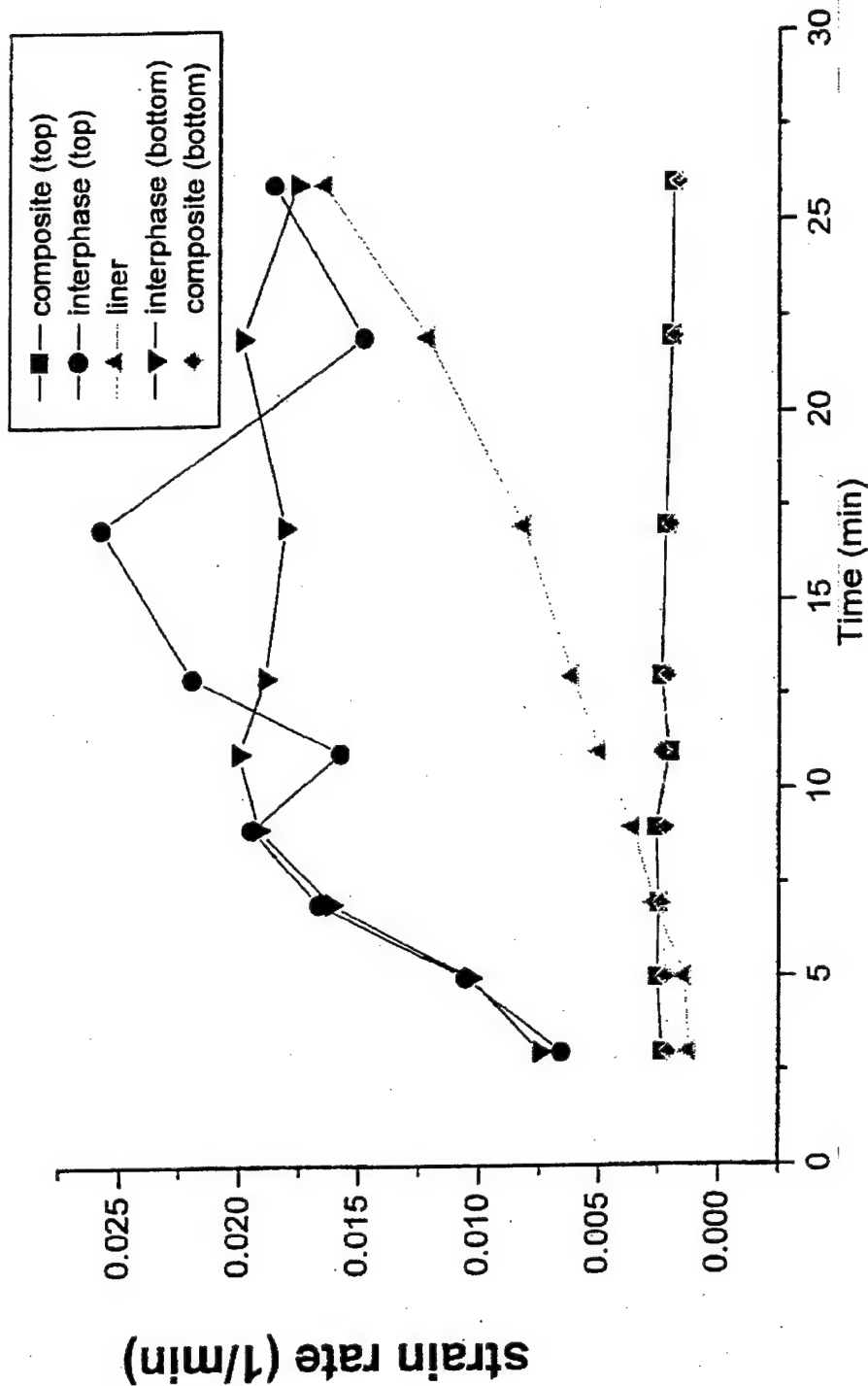
- AB: top part of composite
- BC: top interphase
- CD: pure liner
- DE: bottom interphase
- EF: bottom part of composite



Strain Rate versus Time Curves



Thickness to Width Ratio: 1:2.25

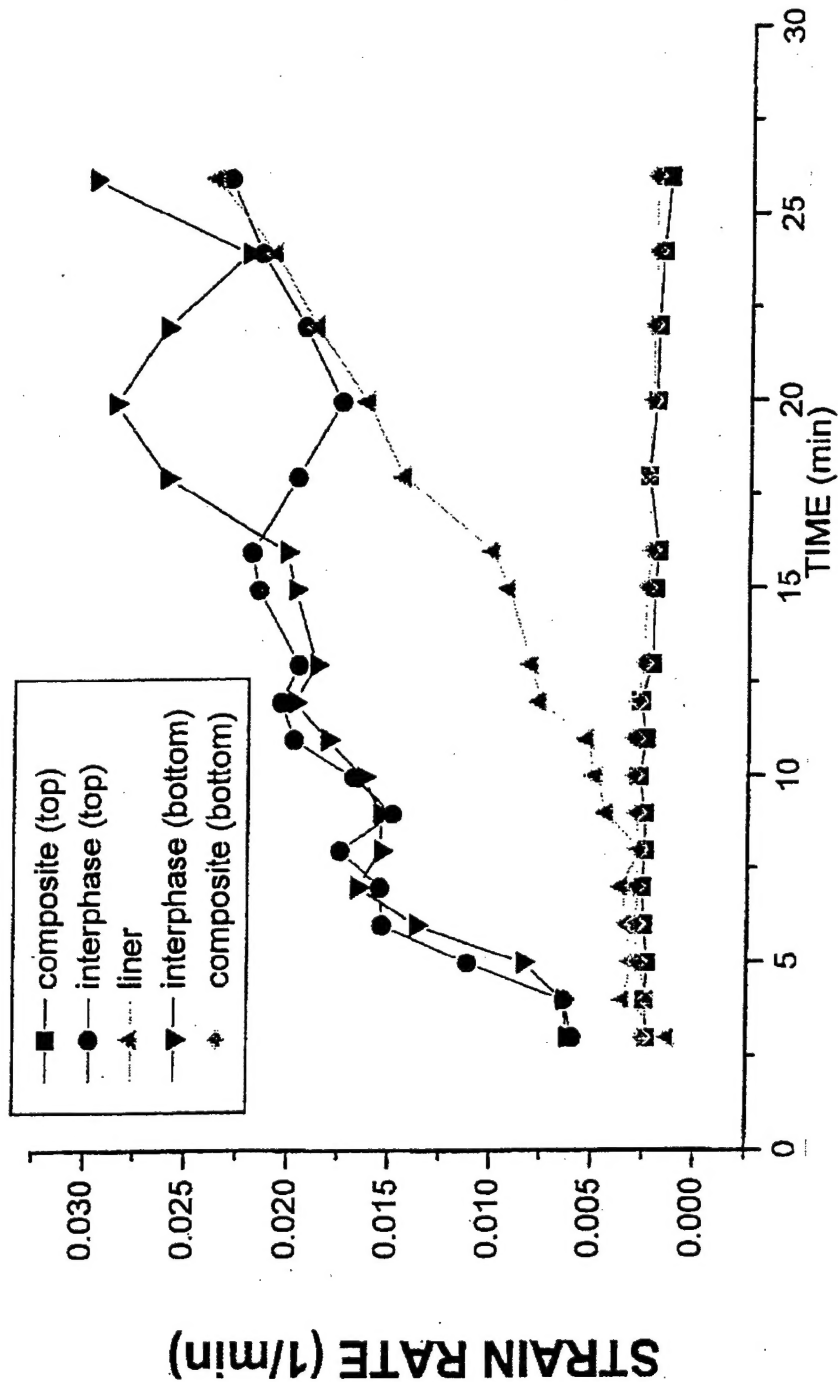




Strain Rate versus Time Curves

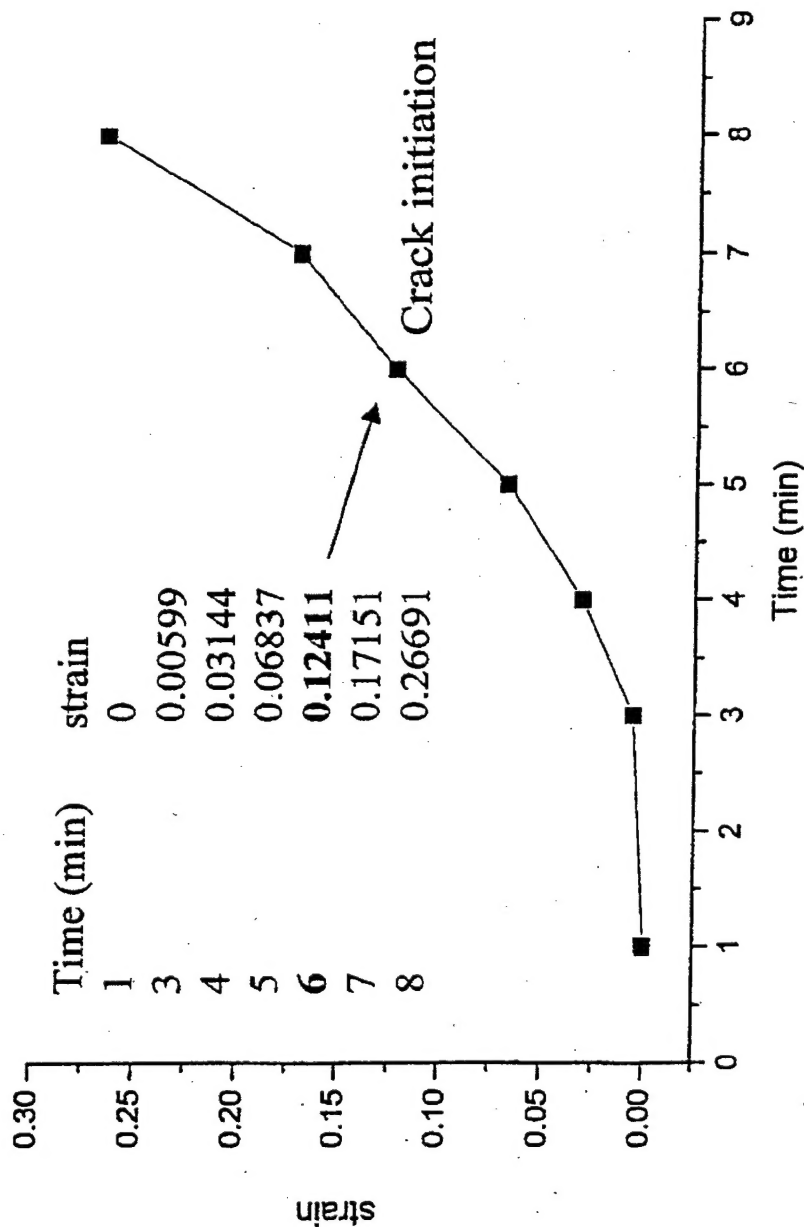


Thickness to Width Ratio: 1:5.00





The Time History of Local Strain near Interface





Summary of Debonding Initiation Strain



Specimen #	Size: t x w (in)	Ratio: t:w	Crack initiation strain
k	0.2 x 1	1:5	0.12
n	0.2 x 0.5	1:2.5	0.14
w	0.2 x 0.45	1:2.25	0.13
o	0.2 x 0.2	1:1	0.13

Conclusions



- ✖ The Failure location depends on the geometry of the specimen.
- ✖ There are interphase regions near the interfaces of the specimen.
- ✖ The strain rates in the rubber layer and the interface region change with time.
- ✖ The strain rate in the interphase region is significant higher than that in the rubber and the composite layers.
- ✖ The average critical local debond strain is 13%, which is independent of specimen geometry.